APPENDIX D

SUPPLEMENT FOR CHAPTER 2

In this appendix, we describe the methods used to analyze the longitudinal teacher survey data presented in Chapter 2, present some additional details on some of the results presented in the chapter, and discuss some additional analyses related to those presented in the chapter. We begin with a discussion of our analyses of the content taught, and then turn to pedagogy.

CONTENT COVERAGE AND HIGH STANDARDS

As reported in Chapter 2, we drew on the baseline wave of the longitudinal survey to describe the content teachers emphasized in their mathematics and science teaching. We then compared the content emphasized by the teachers in our sample to the content emphasized in the National Assessment of Educational Progress. In the following sections, we describe the methods we used to carry out these analyses and we present some results to supplement those discussed in the chapter.

Measuring the Content Taught

Our main data on content come from the baseline wave of the longitudinal survey of teacher change. We characterize the content taught in terms of two major dimensions: the *topics* covered and the *performance goals* teachers hold for students.

In the content section of the survey, we asked teachers to describe the content they taught in the class they chose to describe, using a two-dimensional matrix. Different forms of the matrix were used for elementary, middle, and high school mathematics and science.

The rows of the matrix contain a comprehensive list of the topics and subtopics teachers might cover. The columns of the matrix contain performance goals for students. Performance goals are teachers' expectations for what students should be able to do. There are six performance goals in the matrix: 1) memorize; 2) understand concepts; 3) perform procedures; 4) generate hypotheses; 5) collect, analyze, and interpret data; and 6) make connections. A *content area* can be defined as the intersection of the two dimensions, topics and performance goals.

Each teacher was asked to follow several steps in describing the teacher's course using the matrix. First, the teacher indicated the amount of time given to each subtopic, using a scale from 0 (no time) through 3 (more than two lessons or class periods). Then, the teacher indicated the relative amount of emphasis given to each performance goal, when teaching the subtopic, using a scale from 0 (no emphasis) to 3 (sustained emphasis). We used the full matrix of data provided by each teacher to calculate the percent of the teacher's total class time devoted to each topic and subtopic, each performance goal, and each content area (intersection of a subtopic and performance goal).

To calculate the percent of a teacher's class time developed to each content area, we carried out the following steps:

Step 1. We calculated the number of class periods that the teacher spent on each subtopic. Teachers indicated whether they gave each subtopic a coverage of 0 (no time), 1 (less than one class/lesson), 2 (one to two classes/lessons), or 3 (more than two classes/lessons). To determine the overall percent of total instructional time over the school year given to each subtopic, we recoded the teachers' responses to reflect the number of class periods/lessons spent on each subtopic. We recoded a coverage of 1 as one-half class period/lesson and a coverage of 2 as one and one-half class periods/lessons. Recoding the coverage for each subtopic in which the teacher reported a coverage of 3 (more than two classes/lessons) was more difficult because we do not know for sure *how many more than two classes/lessons* might have been devoted to the subtopic. To recode the 3's, we assumed that each teacher's total coverage across all subtopics should sum to 180 classes, the typical number of classes in a school year in the study schools. We summed the number of class periods accounted for by all subtopics given a coverage of 1 or 2, and subtracted this from 180 to determined the number of class periods remaining. We then divided this by the number of subtopics given a coverage of 3, to estimate the number of class periods devoted to each class period given a coverage of 3.

Step 2. We computed the proportion of the year spent on each subtopic. We carried out this step by dividing the number of class periods spent on each subtopic by 180, the total number of class periods in the year. We then summed across the subtopics under each topic to estimate the proportion of time spent on each topic. The results of these analyses are presented in Exhibit 2.3 for middle school mathematics, and in Exhibits 2.4 and 2.5 for the subtopics related to measurement for grades K-12.

Step 3. We computed the distribution of instructional time across performance goals for each subtopic. For each subtopic the teacher covered, the teacher was asked to report the relative emphasis given to each of the six performance goals, using a scale from 0 (no emphasis) to 3 (sustained emphasis). For each teacher and each subtopic, we determined the relative emphasis given to each performance goal by dividing the emphasis given to that performance goal by the sum of the emphases given to all six performance goals. For example, if a teacher indicated that she taught addition, and she reported an emphasis of 2 for memorizing, an emphasis of 3 for understanding concepts, an emphasis of 1 for making connections, and an emphasis of 0 for the other performance goals, the *total* emphasis for the performance goals for addition would be 2+3+1=6. The *relative emphasis* on memorizing would be 2/6, or 0.33. This relative emphases on performance goals, aggregated across teachers and subtopics, is presented in Exhibit 2.6 for elementary school mathematics.

Step 4. We calculated the relative emphasis given to each content area (subtopic by performance goal). We carried this out for each content area (subtopic by performance goal) by multiplying the proportion of total instructional time spent on the subtopic by the relative emphasis given to the performance goal within the subtopic. The total number of content areas given at least some coverage is summarized in Exhibit 2.8 for elementary, middle, and high school mathematics and science, and the relative emphasis given to specific content areas is presented in Exhibit 2.9b for elementary school science.

Measuring the Content Emphasized in the NAEP

To determine the consistency of the content taught with high standards, we compared the percent of time each teacher devoted to specific topics, performance goals, and content areas to the relative emphasis given to the same topics, performance goals, and content areas by the National Assessment of Educational Progress (NAEP). Mathematics and science generally are tested in every other NAEP administration, or every four years. The data used for these analyses were the 1996 mathematics and science NAEP tests.

To determine the relative amount of emphasis given by the NAEP to each subtopic, performance goal, and content area in our elementary, middle, and high school science and mathematics matrices, we reviewed the full set of NAEP mathematics and science items for the 1996 tests for fourth, eighth, and twelfth grade (see Exhibit D.1).

EXHIBIT D.1

Number of NAEP Items Rated

	Mathematics	Science
Fourth Grade	185	140
Eighth Grade	241	192
Twelfth Grade	248	206

Two science curriculum experts reviewed the full set of NAEP science items to determine the subtopics and performance goals each item tapped, using the matrix of subtopics and performance goals in the longitudinal surveys. Each expert was asked to identify *from one to three* content areas (i.e., subtopic by performance goal cells) that each item tapped. For example, an expert might indicate that a particular 4th-grade NAEP item tapped memorization of a moon fact—a single content area. Or, the expert might indicate that the item tapped three performance goals pertaining to the moon—memorization, understanding, and performing procedures. Or, the expert might indicate that the item tapped three different subtopics, each with an emphasis on performing procedures. Two mathematics curriculum experts conducted similar analyses for the NAEP mathematics items.

The experts rated the items on the 4th-grade NAEP using the matrix of subtopics and performance goals in the elementary school survey; they rated the items on the 8th-grade NAEP using the matrix in the middle school survey; and they rated the items on the 12th-grade NAEP using the matrix in the high school survey.

We examined the inter-rater reliability of the ratings provided by the two mathematics experts, as well as the reliability of the ratings by the two science experts. Exhibit D.2 displays the percent of the ratings for which the two mathematics or science experts agreed exactly in their judgment of the performance goals or subtopics each item tapped. The results indicate that the raters were reasonably similar in their rating of the performance goals emphasized by the NAEP items, with the percent of agreement among ratings ranging from nearly 45 percent to nearly 65 percent, depending on subject (mathematics or science) and grade level (4th-grade, 8th-grade, or 12th-grade). The degree of agreement among ratings for subtopics is somewhat lower, but still substantial, given the large number of subtopics involved. For example, the content matrix for the 12th-grade science survey contains 191 subtopics, some of which are quite closely related (e.g., cell structure/function and cell metabolism), and thus we would not anticipate perfect agreement among ratings.

EXHIBIT D.2

Inter-rater Reliability for Ratings of NAEP Items
(Percent Agreement between Ratings)

	Mathematics			Science		
	Fourth Grade	Eighth Grade	Twelfth Grade	Fourth Grade	Eighth Grade	Twelfth Grade
Subtopics	51.70	50.18	45.85	39.37	44.17	44.12
Performance Goals	44.49	51.97	62.82	64.57	54.17	64.71

To determine the relative amount of emphasis given by the full set of NAEP items to each content area (i.e., each performance goal for each subtopic), we took the following steps.

Step 1. We assigned weights to the ratings given to each item by each rater. To make use of the ratings provided by the experts, we needed to convert the ratings they provided into an estimate of the proportion of emphasis given by NAEP items to each content cell. The process of converting the ratings to a proportion of emphasis is complicated by several factors. First, NAEP items vary in the expected time required to complete them. In estimating the relative emphasis given by the NAEP to each content cell, we weighted items in proportion to NAEP's estimate of the completion time. Second, although in most cases two experts rated each item, in a few cases one of our experts skipped an item. Third, items vary in the number of ratings each of our experts assigned. For some items, raters assigned only a single content cell, while for others, raters assigned as many as three cells.

To take these factors into account, we assigned a weight to each rating by each rater for each item rated. The weight is composed of three factors: 1) the *relative time students were expected to spend on the item* according to NAEP, with a weight of one indicating an item with one correct answer, such as a multiple-choice item and a weight of 2 to 5 indicating a constructed-response item with partial credit possible [1]; 2) the *number of raters* evaluating the item; and 3) the *number of ratings* each rater gave the item. The system of weights ensures that more challenging items are given more weight, that items get equal weight whether they were rated by one rater or two, and that each rater has equal weight, regardless of whether the rater gave the item one, two, or three ratings.

Exhibit D.3 illustrates the weights assigned for the ratings given to a single item by our two raters. In the example, the item is multiple choice in form with only one correct response; it was rated by both raters. Rater 1 assigned the item to two content cells and rater 2 assigned the item to three cells. The item is multiple choice, so the weight reflecting the expected completion time=1.

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[1] We used the number of Item Response Theory (IRT) parameters as the weight for the items. More complex items require more IRT parameters, so they are weighed more heavily. Dichotomous items (i.e., items that are graded as either right or wrong, including all multiple-choice and some short-answer items) have one IRT parameter, and so are weighted by one. Short constructed-response items are questions that "required students to provide answers to computation problems or to describe solutions in one or two sentences"; these items are expected to take two to three minutes to complete (Reese et al., 1997, p. 79). Extended constructed-response items "required students to provide longer answers (e.g., a description of possibilities, a more involved computational analysis, or a description of a patterns and its implications)"; these items are expected to take five minutes to complete (Reese et al., 1997, p. 79).

Both raters rated the item, so the number of raters=2, and the weight for each rater is 1/2, or 0.5. The first rater assigned two ratings to the item; thus, for the first rater, the weight for each rating=1/2, or 0.5. The second rater assigned three ratings to the item; so, for the second rater, the weight for each rating is 1/3 or 0.33.

The three weights pertaining to each rating of each item by each rater are multiplied to obtain a total weight for the rating. Thus, in the example in Exhibit D.3, the weight assigned to the first rating given by the first rater = 0.5*0.5=0.25.

EXHIBIT D.3

Example of Weights for Ratings of One Item

	NAEP Item weight	Rater Weight	Number of Ratings Weight	Total Weight
Rater 1				
Rating 1	1	.50	.50	.25
Rating 2	1	.50	.50	.25
Rater 2				
Rating 1	1	.50	.33	.165
Rating 2	1	.50	.33	.165
Rating 3	1	.50	.33	.165

Step 2. We determined the relative emphasis given by the NAEP to each subtopic. To carry out this step, we summed the total number of weighted rating points given to each subtopic and divided by the total number of rating points given to all subtopics. The relative emphasis given by the NAEP to topics is presented in Exhibit 2.3 for middle school mathematics.

Step 3. We determined the relative emphasis given by the NAEP to each performance goal. To carry out this step, we summed the total number of weighted rating points given to each performance goal and divided by the total number of rating points given to all performance goals. The relative emphasis given by the NAEP to each performance goal is presented in Exhibit 2.6 for elementary school mathematics.

Step 4. We determined the relative emphasis given by the NAEP to each content cell (subtopic by performance goal). To carry out this step, we summed the total number of rating points given to each content cell, and divided by the total rating points given to all cells. This relative emphasis given by the NAEP to content areas is summarized in Exhibit 2.8 and presented in more detail for elementary science in Exhibit 2.9a.

Step 5. We determined the alignment of teachers' reports and the NAEP. As a final step in our analysis, we computed an index of alignment for each teacher, measuring the degree to which the teacher's relative emphasis on each content cell matches the NAEP. We based the index of alignment on Gamoran, Porter, Smithson, and White (1997). For each teacher, the index is computed as the sum, across content areas, of the absolute value of the difference between the emphasis given by the teacher to the content area and the emphasis given by the NAEP. The absolute value is required because the index is designed to capture cells for which the teachers give

more emphasis than NAEP, as well as those for which they give *less* emphasis. The index is scaled to range from 0.0 to 1.0. The results of the alignment index are presented in Exhibit 2.10.

Supplementary Tables

Topic emphases and high standards. In Exhibit 2.3, we described teachers' emphases on topics, using middle school mathematics teachers as an example. Here, we present the topics emphasized by teachers in the remaining five subgroups: elementary and high school mathematics; and elementary, middle, and high school science.

EXHIBIT D.4a

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – Elementary School Math (n=74)

EXHIBIT D.4b

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – High School Math (n=69)

EXHIBIT D.4c

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics - Elementary School Science (n=69)
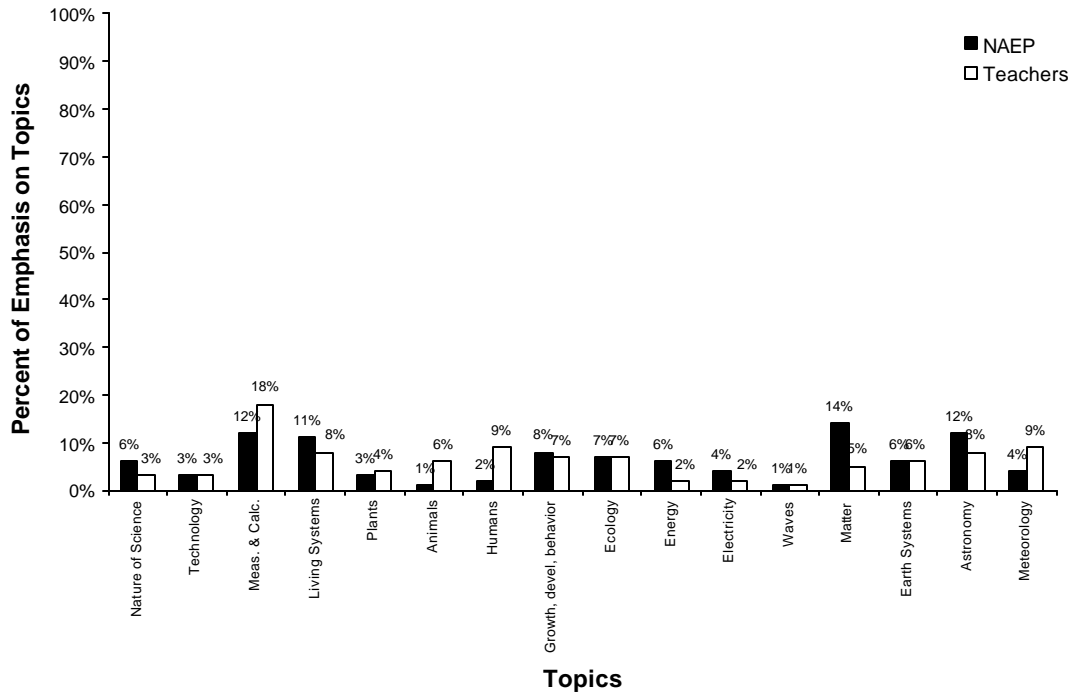
EXHIBIT D.4d

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – Middle School Science (n=41)

EXHIBIT D.4d (Continued)

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – Middle School Science (n=41)
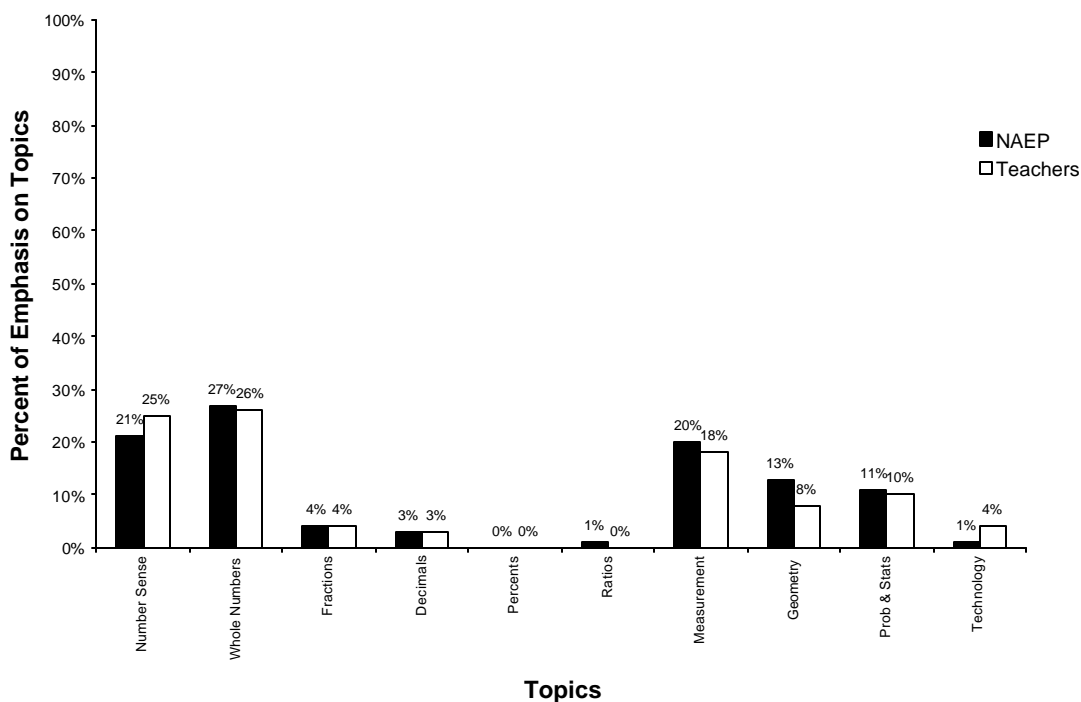
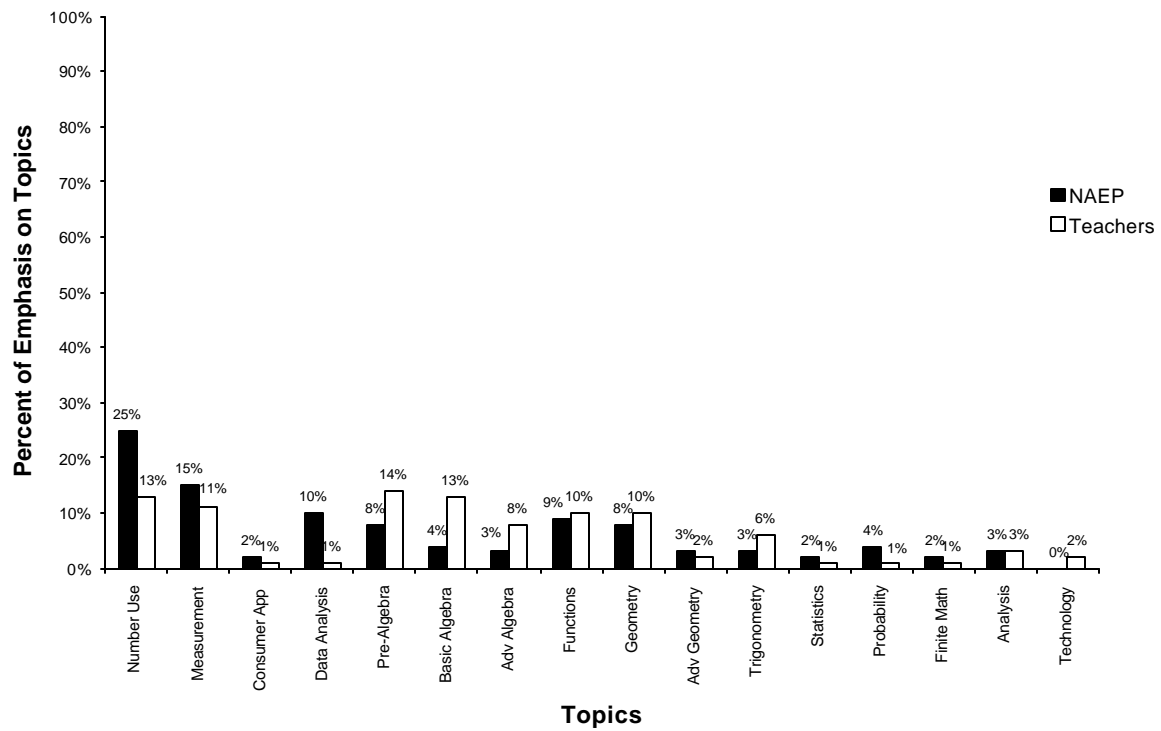# EXHIBIT D.4e

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – High School Science (n=64)

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Topics – High School Science (n=64)
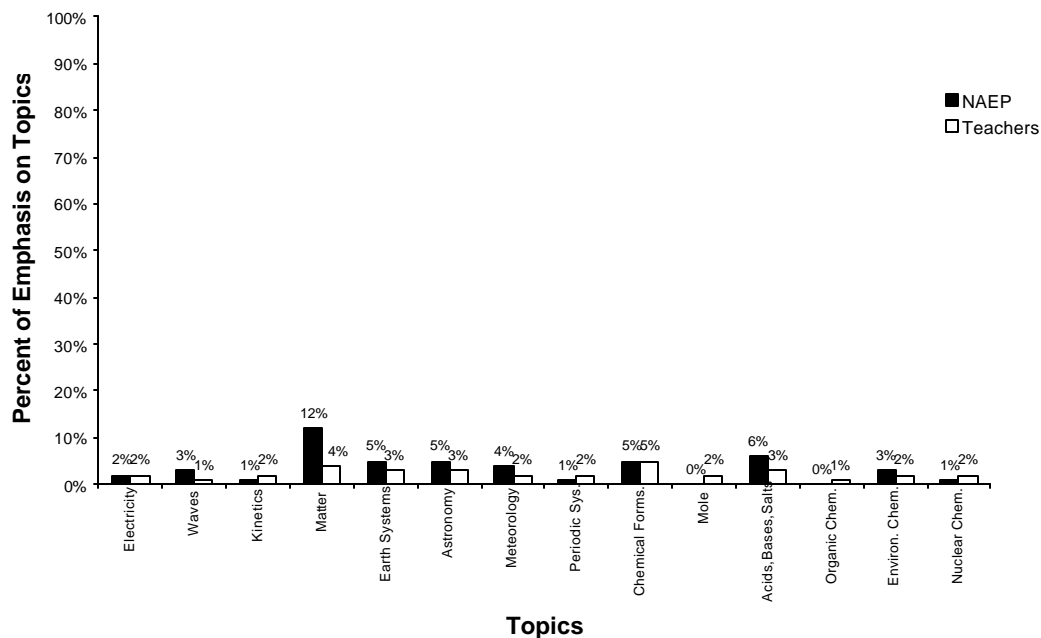
Performance goals and high standards. In Exhibit 2.6, we described the performance goals teachers hold for students, using elementary school mathematics teachers as an example. Here we present the performance goals of teachers for the remaining five subgroups: middle and high school mathematics; and elementary, middle, and high school science.

EXHIBIT D.5a

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Performance Goals - Middle School Math (n=38)
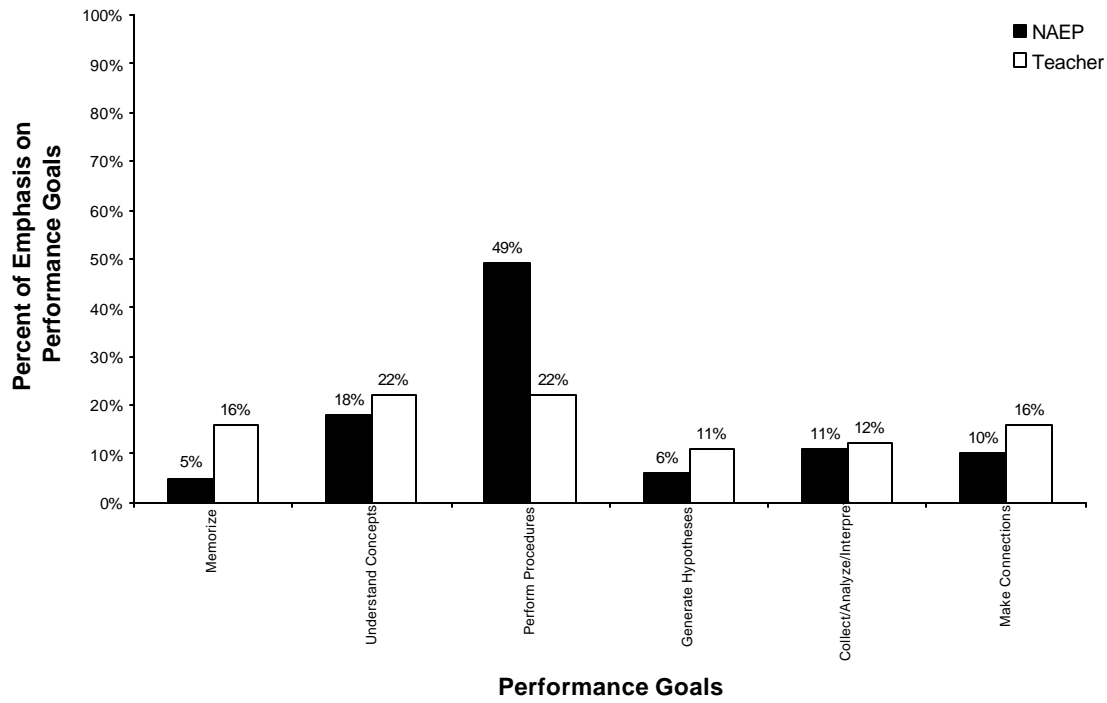
EXHIBIT D.5b

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Performance Goals – High School Math (n=69)
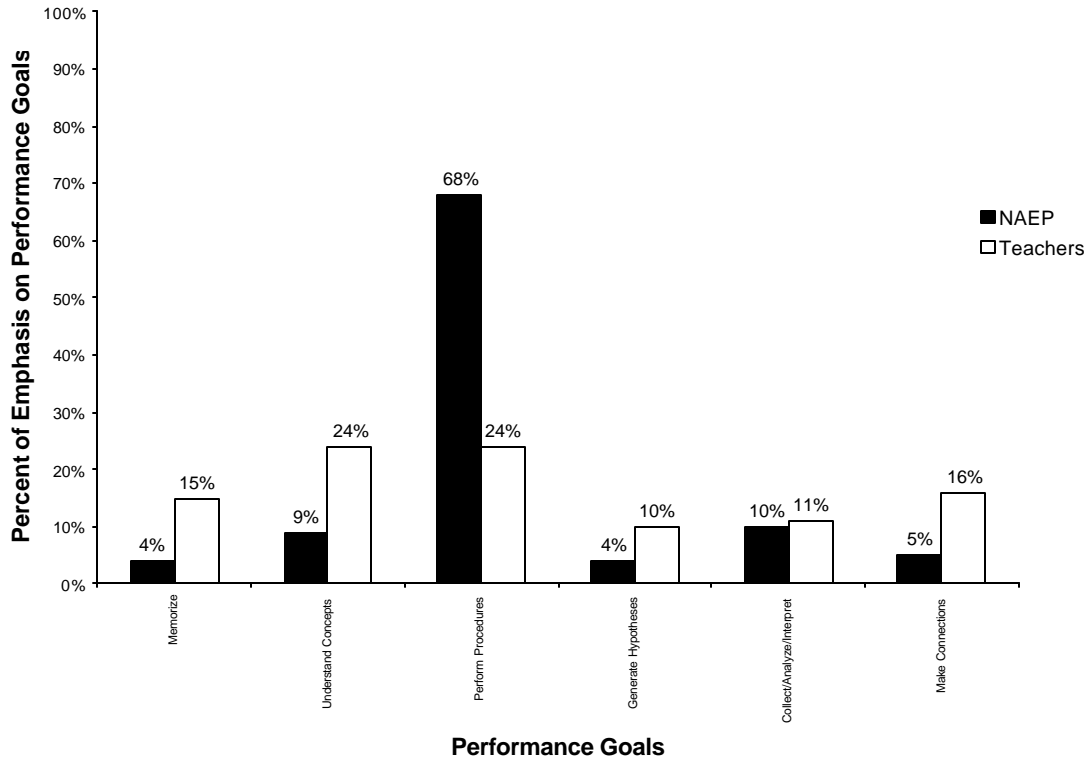
EXHIBIT D.5c

Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Relative Emphasis on Performance Goals – Elementary School Science (n=69)
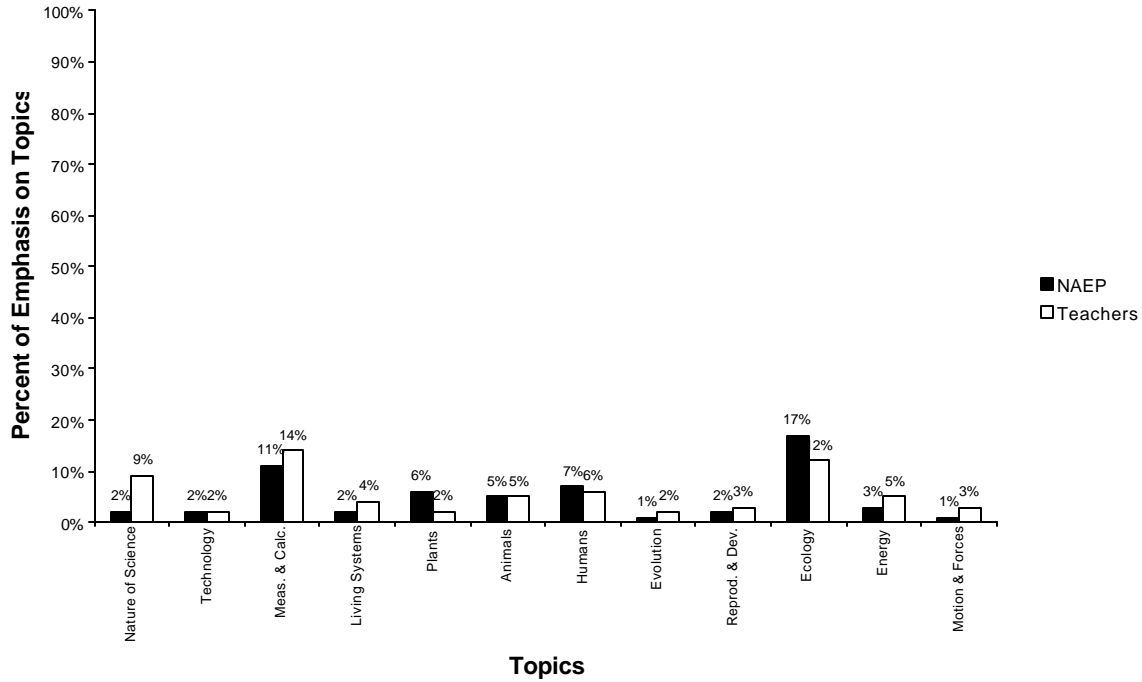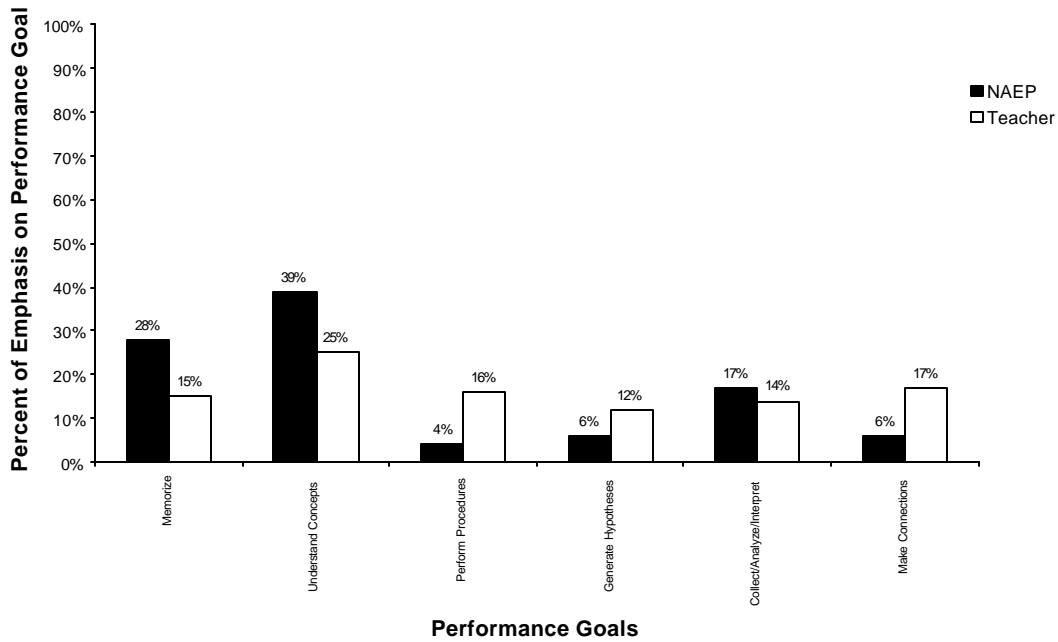
EXHIBIT D.5d

Comparison of NAEP and Teachers on the Longitudinal Teacher Survey on Emphasis on Performance Goals – Middle School Science (n=41)
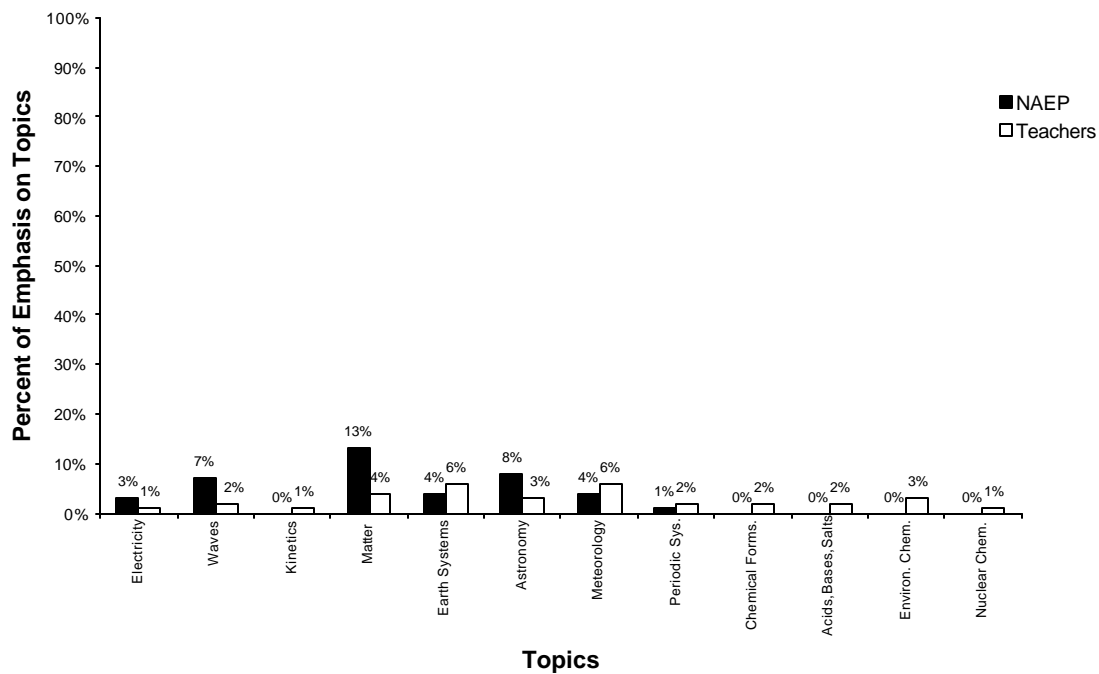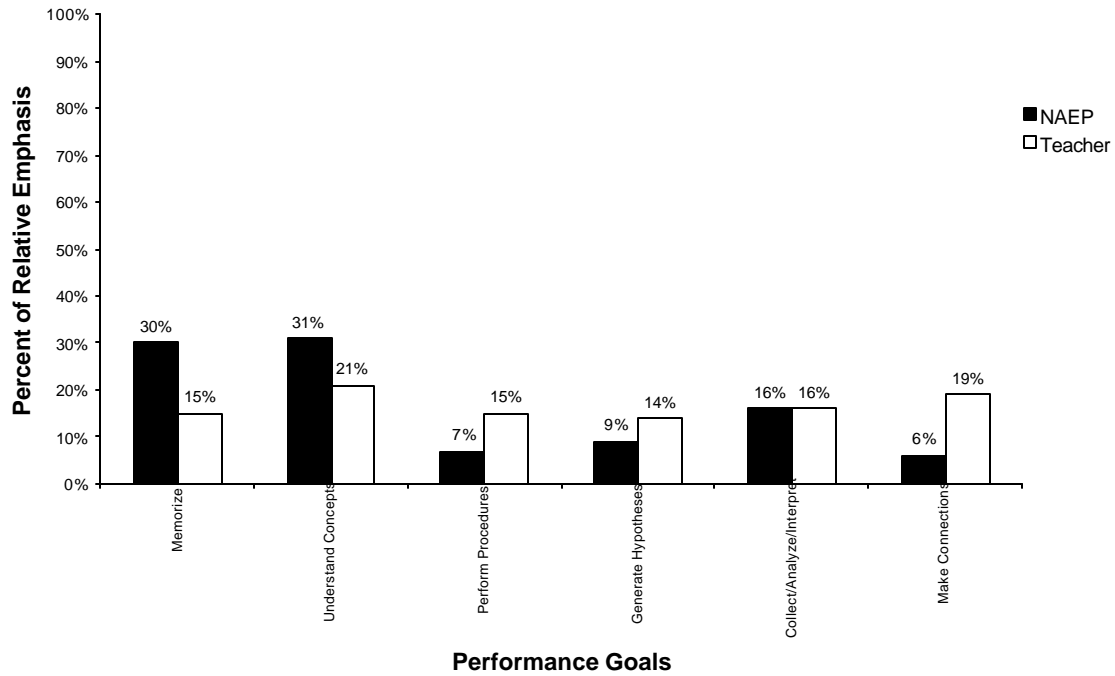
Comparison of NAEP and Teachers in the Longitudinal Teacher Survey on Emphasis on Performance Goals – High School Science (n=64)
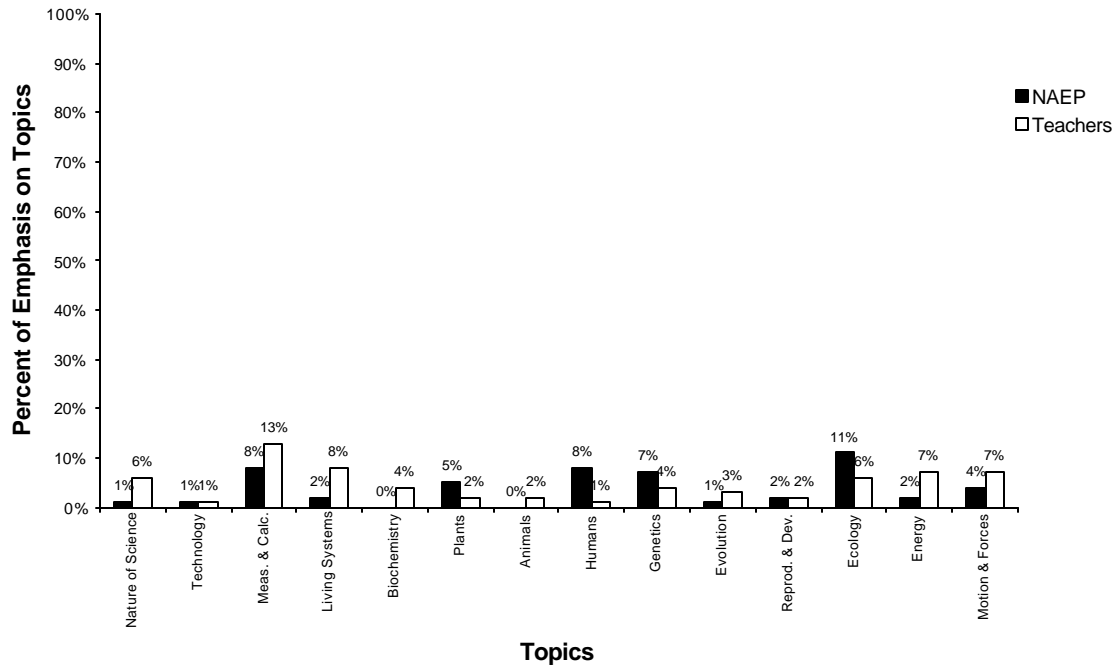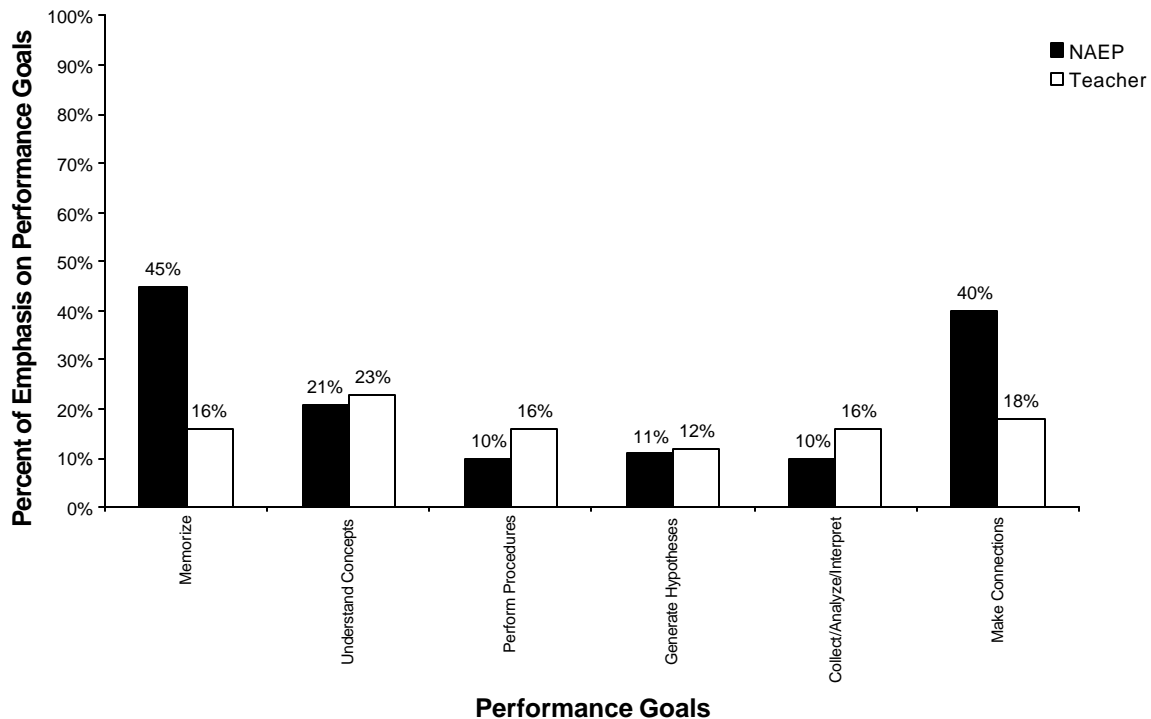

Exhibit 2.7 in Chapter 2 displays significant differences in performance goals among schools and types of teachers. We conducted MANOVAs to determine whether school level (i.e., elementary, middle, high school), subject (i.e., mathematics or science), or poverty level of the school affects the types of performance expectations teachers held for students. The results are shown in Exhibit D.6, below.

EXHIBIT D.6

Effects of School Level, Subject, and Poverty on Teachers' Emphasis on Performance Goals
F-Values, Tukey Pairwise Contrasts, and df (n=355)

	Memorize		Understand Concepts		Perform Procedures		Generate Hypothesis		Collect/ Analyze/ Interpret		Make Connections	
School Level	0.23	(df=2, 349)	1.61	(df=2, 349)	4.78**	(df=2, 349)	1.55	(df=2, 349)	0.51	(df=2, 349)	0.74	(df=2, 349)
HS-MS	0.00	(df=349)	0.02	(df=349)	0.02*	(df=349)	-0.02*	(df=349)	-0.01	(df=349)	-0.01	(df=349)
HS-ES	-0.00	(df=349)	-0.00	(df=349)	0.02*	(df=349)	-0.01	(df=349)	-0.00	(df=349)	-0.00	(df=349)
MS-ES	-0.00	(df=349)	-0.02	(df=349)	0.00	(df=349)	0.01	(df=349)	0.01	(df=349)	0.00	(df=349)
Subject	0.19	(df=1, 349)	0.25	(df=1, 349)	131.75***	(df=1, 349)	9.88**	(df=1, 349)	26.94***	(df=1, 349)	6.28**	(df=1, 349)
School Poverty Level	4.34*	(df=1,349)	6.45*	*(df=1,349)	0.62	(df=1,349)	2.16	(df=1,349)	1.31	(df=1,349)	0.22	(df=1,349)

*   Significant at p<.05
**   Significant at p<.01
***   Significant at p<.001

Content emphasis and high standards.   Chapter 2, Exhibit 2.9, shows the relative emphasis teachers and the NAEP place on content areas for elementary school science. Here, we display the same information for the remaining five subgroups: elementary, middle, and high school mathematics; and middle and high school science.

EXHIBIT D.7a

Emphasis on Content Areas in Fourth-Grade Math NAEP Items

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Number sense	Over 3%	Over 3%	Over 3%	1-2%	Over 3%	Under 1%
Whole numbers	Under 1%	Over 3%	Over 3%	1-2%	1-2%	2-3%
Fractions	Under 1%	2-3%	1-2%	Under 1%	Under 1%	Under 1%
Decimals	Under 1%	Under 1%	2-3%	Under 1%	Under 1%	Under 1%
Percents	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%
Ratios/proportions	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%
Measurement	Over 3%	2-3%	Over 3%	Over 3%	2-3%	Under 1%
Basic Geometry	Over 3%	2-3%	Over 3%	Under 1%	Under 1%	Under 1%
Probability/statististics	Under 1%	Under 1%	Over 3%	Under 1%	Over 3%	Under 1%
Technology	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%	Under 1%

Legend: Under 1%   1-2 %   2-3 %   Over 3 %

EXHIBIT D.7b

Emphasis on Content Areas, Reported by Elementary School Math Teachers in the Longitudinal Teacher Survey (n=74)

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Number sense	over .03	over .03	over .03	.02 to .03	over .03	over .03
Whole numbers	over .03	over .03	over .03	.02 to .03	over .03	over .03
Fractions	under .01	.01 to .02	.01 to .02	under .01	under .01	under .01
Decimals	under .01	under .01	under .01	under .01	under .01	under .01
Percents	under .01	under .01	under .01	under .01	under .01	under .01
Ratios/proportions	under .01	under .01	under .01	under .01	under .01	under .01
Measurement	.02 to .03	over .03	over .03	.01 to .02	.02 to .03	.02 to .03
Basic Geometry	.01 to .02	.01 to .02	.01 to .02	under .01	under .01	.01 to .02
Probability/statistics	under .01	.02 to .03	.02 to .03	.01 to .02	.01 to .02	.01 to .02
Technology	under .01	under .01	.01 to .02	under .01	under .01	under .01

TMEAN: [white] under .01 [horizontal lines] .01 to .02 [grid] .02 to .03 [gray] over .03
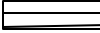
Emphasis on Content Areas in Eighth-Grade Math NAEP Items
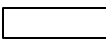
	Memorize	Understand	Perform procedure	Generate hypotheses	Collect data	Make connections
Number Sense	under .01	.02 to .03	over .03	under .01	.02 to .03	under .01
Computation	under .01	over .03	over .03	.01 to .02	.01 to .02	under .01
Measurement	.01 to .02	over .03	over .03	.01 to .02	.01 to .02	over .03
Analysis/Prob	under .01	.02 to .03	over .03	.01 to .02	over .03	under .01
Pre-Algebra	under .01	.01 to .02	over .03	under .01	under .01	under .01
Basic Algebra	under .01	.01 to .02	over .03	under .01	under .01	.01 to .02
Advanced Algebra	under .01	.01 to .02	.01 to .02	under .01	under .01	.01 to .02
Geometry	.02 to .03	.01 to .02	over .03	.01 to .02	.01 to .02	.01 to .02
Technology	under .01	under .01	under .01	under .01	under .01	under .01

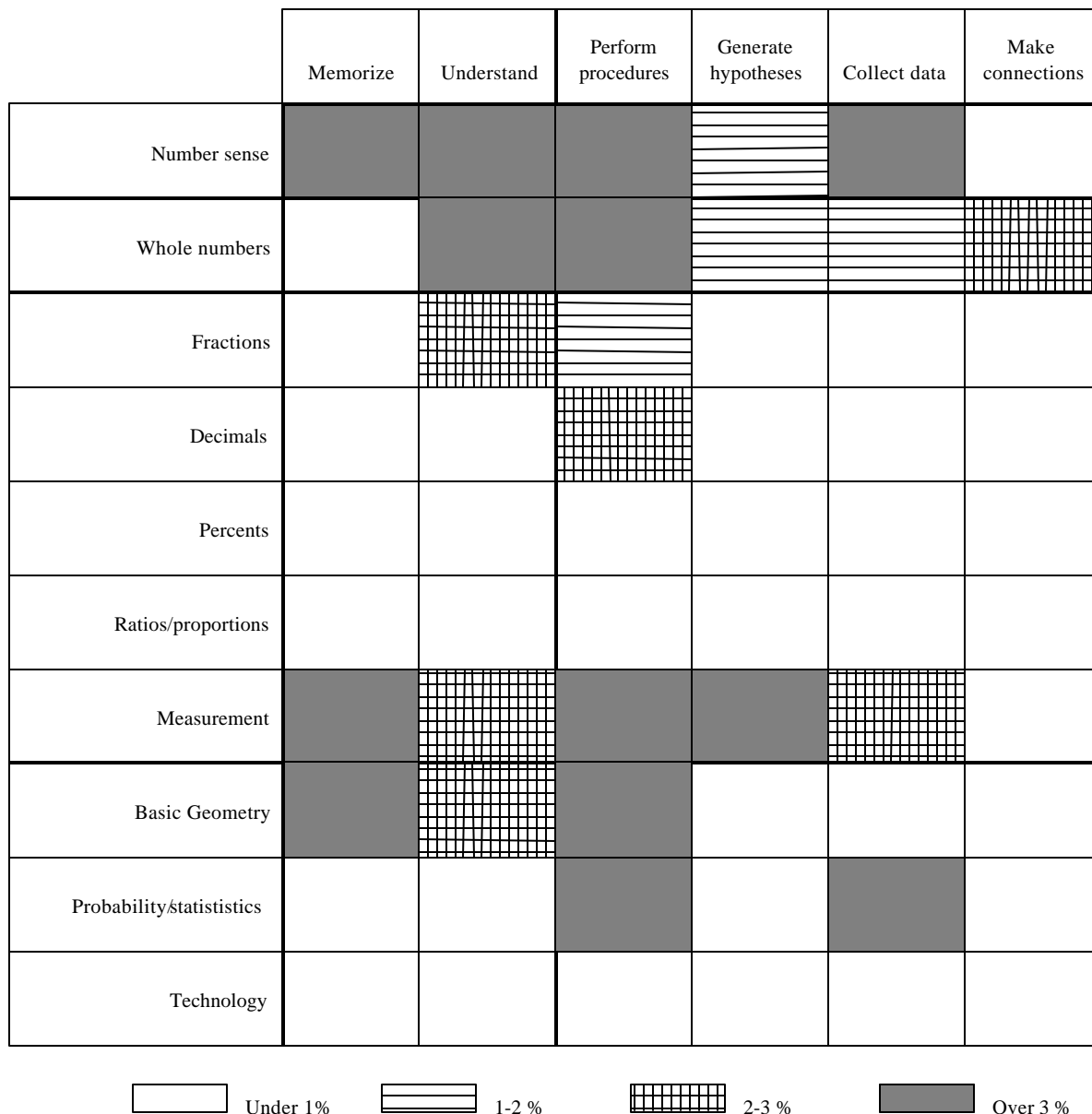NMEAN: □ under .01   ▤ .01 to .02   ▦ .02 to .03   ■ over .03

EXHIBIT D.7d

Emphasis on Content Areas, Reported by Middle School Math Teachers in the Longitudinal Teacher Survey (n=38)

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Number Sense						
Computation						
Measurement						
Analysis/Prob						
Pre-Algebra						
Basic Algebra						
Advanced Algebra						
Geometry						
Technology						

TMEAN [ ] under .01   [≡] .01 to .02   [▦] .02 to .03   [■] over .03

EXHIBIT D.7e

Emphasis on Content Areas in Twelfth-Grade Math NAEP Items

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Number Use		over .03	over .03		.01 to .02	
Measurement		.01 to .02	over .03			.01 to .02
Consumer Application			.01 to .02			
Data Analysis		.01 to .02	over .03		over .03	
Pre-Algebra			over .03			
Basic Algebra			.02 to .03			
Advanced Algebra			.02 to .03			
Functions		.01 to .02	over .03			
Geometry	.01 to .02		over .03	.01 to .02		
Advanced Geometry			.01 to .02			
Trigonometry			.01 to .02			
Statistics			.01 to .02			
Probability			over .03			
Finite Math			.01 to .02			
Analysis						.01 to .02
Technology						

NMEAN ☐ under .01   ☐ .01 to .02   ▦ .02 to .03   ■ over .03

Emphasis on Content Areas, Reported by High School Math Teachers in the Longitudinal Teacher Survey (n=69)

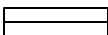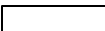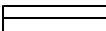|	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Number Use	.01 to .02	.02 to .03	over .03	.01 to .02	.01 to .02	.02 to .03
Measurement	.01 to .02	.02 to .03	.02 to .03	.01 to .02	.01 to .02	.01 to .02
Consumer Application						
Data Analysis						
Pre-Algebra	.02 to .03	over .03	over .03	.01 to .02		.02 to .03
Basic Algebra	.01 to .02	over .03	over .03	.01 to .02		.01 to .02
Advanced Algebra	.01 to .02	.01 to .02	.02 to .03			.01 to .02
Functions	.01 to .02	.02 to .03	.02 to .03			.01 to .02
Geometry	.01 to .02	.02 to .03	.02 to .03			.01 to .02
Advanced Geometry						
Trigonometry	.01 to .02	.01 to .02	.01 to .02			
Statistics						
Probability						
Finite Math						
Analysis						
Technology						

TMEAN ☐ under .01   ▤ .01 to .02   ▦ .02 to .03   ■ over .03

EXHIBIT D.7g

Emphasis on Content Areas in Eighth-Grade Science NAEP Items

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Nature of Science						
Technology						.01 to .02
Measurement		over .03	over .03		over .03	
Living Systems	.01 to .02					
Plants		.02 to .03			.01 to .02	
Animals	.01 to .02			.01 to .02		
Humans	over .03	.02 to .03				
Evolution						
Reproduction						
Ecology	.02 to .03	over .03		.02 to .03	.02 to .03	over .03
Energy	.01 to .02					
Motion & Forces						
Electricty	.02 to .03					
Waves	over .03	.02 to .03				
Kinetics & Equilibri						
Properties of Matter	.02 to .03	.01 to .02		.02 to .03	over .03	
Earth Systems	over .03					
Astronomy		over .03				
Meteorology	.01 to .02	.01 to .02				
Elements						
Chem Formulas & Reac						
Acids, Bases, Salts						
Environmental Chemis						
Nuclear Chemistry						

NMEAN [ ] under .01   [≡] .01 to .02   [▦] .02 to .03   [■] over .03

EXHIBIT D.7h
Emphasis on Content Areas in Middle School Science, Reported in the Longitudinal Teacher Survey (n=41)

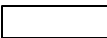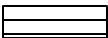|	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Nature of Science						
Technology						
Meas & Calc			.02 to .03	.02 to .03	.01 to .02	
Living Systems	.01 to .02					
Biochemistry						
Plants	.01 to .02				over .03	
Animals						
Humans	over .03	.02 to .03				
Genetics	over .03	.01 to .02				
Evolution						
Reproduction & Dev						
Ecology	.02 to .03	over .03		.02 to .03	.01 to .02	
Energy	.01 to .02					
Motion & Forces	over .03					
Electricity	.01 to .02	.01 to .02				
Waves	.02 to .03	.01 to .02				
Kinetics & Equilib						
Matter	over .03	.01 to .02		over .03		
Earth Systems	.02 to .03	.02 to .03				
Astronomy		.02 to .03				
Meteorology	over .03					
Elements						
Chemistry	over .03					
Mole						
Acids, Bases, Salts	.01 to .02		.01 to .02			
Org Chem						
Environmental Sci	.01 to .02	.01 to .02				
Nuclear Chem						

NMEAN ☐ under .01   ▤ .01 to .02   ▦ .02 to .03   ■ over .03

EXHIBIT D.7i
Emphasis on Content Areas in Twelfth-Grade Science NAEP Items

Shading legend — TMEAN: blank = under .01; horizontal lines (≡) = .01 to .02; grid (#) = .02 to .03

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Nature of Science	≡	≡	≡	≡	≡	≡
Technology						
Measurement	≡	#	#		#	#
Living Systems						
Plants						
Animals		≡				
Humans	≡	≡				≡
Evolution						
Reproduction						
Ecology	≡	#			#	#
Energy						
Motion & Forces						
Electricty						
Waves						
Kinetics & Equilibri						
Properties of Matter						
Earth Systems		≡				≡
Astronomy						
Meteorology		≡				≡
Elements						
Chem Formulas & Reac						
Acids, Bases, Salts						
Environmental Chemis						
Nuclear Chemistry						
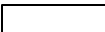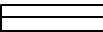
TMEAN: [ ] under .01   [≡] .01 to .02   [#] .02 to .03

Emphasis on Content Areas, Reported by High School Science Teachers in the Longitudinal Teacher Survey (n=64)

	Memorize	Understand	Perform procedures	Generate hypotheses	Collect data	Make connections
Nature of Science						
Technology						
Meas & Calc						
Living Systems						
Biochemistry						
Plants						
Animals						
Humans						
Genetics						
Evolution						
Reproduction & Dev						
Ecology						
Energy						
Motion & Forces						
Electricity						
Waves						
Kinetics & Equilib						
Matter						
Earth Systems						
Astronomy						
Meteorology						
Elements						
Chemistry						
Mole						
Acids, Bases, Salts						
Org Chem						
Environmental Sci						
Nuclear Chem						
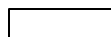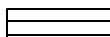
TMEAN   under .01   .01 to .02   .02 to .03

Alignment between content emphases and high standards. Exhibit 2.10 in Chapter 2 displays the degree of alignment between teachers' instructional emphases and NAEP emphases. Here, Exhibit D.8 provides the means and standard deviations for the graphic representation of alignment in Exhibit 2.10.

EXHIBIT D.8

Alignment between Teachers' Instruction and NAEP Emphasis (n=355)

Index	Mathematics			Science		
	Elementary School	Middle School	High School	Elementary School	Middle School	High School
Mean	27.1	28.8	19.2	14.7	15.0	11.5
Standard Deviation	10.8	7.5	6.0	8.2	5.0	3.6

To better understand the conditions under which teachers' instruction aligned with NAEP, we examined the relationship between alignment and the following factors.

- *School level:* Is there a difference among elementary, middle, and high school teachers in their alignment to NAEP? Using the general linear models procedure with our sample of 354 teachers, across three types of schools, we found that alignment differs by school level ($F=16.55$***, df=2, 351).

- *Subject:* Is there a difference between mathematics and science teachers? Using the general linear models procedure with our sample of 354 teachers, across two subjects, we found that alignment differs by subject ($F=159.56$***, df=1, 352).

- *Specific schools:* Is there a difference among schools in how well teachers' instruction is aligned with NAEP? Using the general linear models procedure with our sample of 354 teachers, in 29 schools, we found that schools differ significantly in how well their teachers' instruction aligns with NAEP ($F=2.10$**, df=28, 325).

- *Grade level:* For example, is there a difference among ninth-, tenth-, eleventh-, and twelfth-grade science teachers in how well their instruction is aligned with NAEP? We used the general linear models procedure to examine this question within each subgroup (e.g., high school science). We found that, with the exception of elementary school mathematics, alignment does not differ much across grades within schools at the same level (i.e., elementary, middle, or high; see Exhibit D.9).

- *School poverty level:* Is there a difference among teachers in high poverty versus low poverty schools in how well their instruction aligns with NAEP? We used the general linear models procedure to examine this question within each subgroup (e.g., high school science). We found that alignment does not differ much between high- and low-poverty schools (see Exhibit D.9).

EXHIBIT D.9

Effects of Grade Level and Subject on Alignment between Teachers' and NAEP's Content Emphases MANOVA Tests: F-Values and Degrees of Freedom (df) (n=355)

	Mathematics			Science		
	Elementary School	Middle School	High School	Elementary School	Middle School	High School
Grade Level	24.93***	.19	2.18	1.91	.55	1.12
	df=5, 62	df=2, 35	df=3, 65	df=5, 58	df=2, 37	df=4, 57
School Poverty	.42	4.07	.11	.34	.87	.39
	df=1, 72	df=1, 36	df=1, 67	df=1, 66	df=1, 39	df=1, 62

*   Significant at $p<.05$
**   Significant at $p<.01$
***   Significant at $p<.001$

PEDAGOGY AND HIGH STANDARDS

In the sections below, we discuss the scales measuring pedagogical approaches discussed in Chapter 2, and we then present several results that supplement the material in the chapter.

Pedagogical approaches

We conducted analyses on a series of items in the longitudinal survey about teachers' pedagogical strategies. (See Exhibit D.10 for the items involved.)

EXHIBIT D.10

Pedagogy Questions Drawn from Middle School Mathematics Survey

1. Indicate the percentage of time in the target class you spent on math instruction in each of the following activities. (Note: Total should sum to 100%.)

Teacher Activities	Percent of Instr. Time
a. Lecturing to the class………………………………	_____
b. Providing demonstrations to the class (including lab demonstrations)………………………………..	_____
c. Leading whole class discussions…………………..	_____
d. Working with students in small groups……………	_____
e. Working with students individually	_____
f. Performing routine administrative tasks (e.g., taking attendance, making announcements, etc.)..................................	_____
g. Helping students with experiments, projects, or other hands-on experiences...	_____
h. Other: (please specify) _____	_____
TOTAL	100%

2. Indicate the percentage of class time spent on math instruction that the typical student is engaged in each of the following activities. (Note: Total should sum to 100%.)

Student Activities	Percent of Instr. Time
a. Listening/taking notes/observing demonstrations.................................	_____
b. Engaged in discussion	_____
c. Doing lab or field work...	_____
d. Completing exercises/taking a test or quiz	_____
e. Reading..………………………………………………….	_____
f. Completing a performance task, writing………………	_____
g. Presenting material to the class.………………………	_____
h. Other: (please specify) _____	_____
TOTAL	100%

Pedagogy Questions Drawn from Middle School Mathematics Survey

3. How often did you have students (during math): (Circle one for each line.)

		Almost Never	Some Lessons	Most Lessons	Every Lesson
a.	Work on or review homework in class	0	1	2	3
b.	Work on paper-and-pencil exercises related to the topic..	0	1	2	3
c.	Work on independent, long-term (at least one-week) projects...	0	1	2	3
d.	Work on problems for which there is no immediately obvious method or solution..........................	0	1	2	3
e.	Develop technical or mathematical writing skills, including using equations, graphs, tables, and text together	0	1	2	3
f.	Work on interdisciplinary lessons (e.g., writing journals in class)	0	1	2	3
g.	Recite or drill orally	0	1	2	3
h.	Debate ideas or otherwise explain their reasoning...	0	1	2	3
i.	Complete a short test or quiz to review previous lesson	0	1	2	3
j.	Use concrete models or manipulatives...........................	0	1	2	3

4. About how often did students use the following as part of math instruction: (Circle one for each line.)

		Almost Never	Some Lessons	Most Lessons	Every Lesson
a.	Standard calculators to solve basic exercises or problems	0	1	2	3
b.	Programmable calculators to solve advanced exercises or problems	0	1	2	3
c.	Graphing calculators to graph equations or data	0	1	2	3
d.	Calculators or computers to develop models or simulations...	0	1	2	3
e.	Calculators or computers for data collection and analysis..	0	1	2	3
f.	Computers for drill and practice on skill acquisition..				
g.	Computers to write reports...	0	1	2	3
h.	Computers to access the internet....................................	0	1	2	3

Pedagogy Questions Drawn from Middle School Mathematics Survey

6. About how often did you interact with students in the targeted class in the following ways: (Circle one for each line.)

		Almost Never	Some Lessons	Most Lessons	Every Lesson
a.	Students work individually without your ongoing assistance	0	1	2	3
b.	Students work individually with your ongoing assistance	0	1	2	3
c.	Work together as a class with students responding to one another…………………	0	1	2	3
d.	Work in pairs or small groups without your ongoing assistance...	0	1	2	3
e.	Work in pairs or small groups with your ongoing assistance...	0	1	2	3

7. How important were the following assessment strategies in determining students' grades in this math class: (Circle one for each line.)

		Not Used	Minor Importance	Moderate Importance	Very Important
a.	Objective tests (e.g., multiple choice)..........	0	1	2	3
b.	Essay tests..	0	1	2	3
c.	Performance tasks or events	0	1	2	3
d.	Systematic observation of students..	0	1	2	3
e.	Math reports	0	1	2	3
f.	Math projects	0	1	2	3
g.	Homework assignments	0	1	2	3
h.	Portfolios...	0	1	2	3

To identify patterns in teachers' pedagogical activities, we conducted factor analyses on the full set of items identified in Exhibit D.10. The following four factors, consistent with research on pedagogy, emerged.

Didactic instruction. (alpha reliability=.75).

- Students working on interdisciplinary lessons (reverse coded)

- Students using concrete models or manipulatives (reverse coded)

- Teacher lecturing to class

- Teacher working with students in small groups (reverse coded)

- Students listening/taking notes/observing demonstration

- Students reading (reverse coded)

- Students completing a performance task, writing (reverse coded)

- Students presenting material to the class (reverse coded)

Individual Seatwork. (alpha reliability=.69).

- Students working on or reviewing homework in class

- Students working on paper-and-pencil exercises related to the topic

- Students reciting or drilling orally

- Students completing a short test or quiz to review previous lesson

- Students work individually without your ongoing assistance

- Students work individually with your ongoing assistance

- Students work in pairs or small groups without your ongoing assistance

Active, project-centered instruction. (alpha reliability=.67).

- Students working on independent, long-term projects

- Students working on problems for which there is no immediately obvious method or solution

- Students developing technical or mathematical/scientific writing skills

- Teacher working with students individually (reverse coded)

- Teacher helping students with experiments, projects, or other hands-on experiences

- Students doing lab or field work

- Students completing exercises/taking a test or quiz (reverse coded)

- Students doing other (reverse coded)

Discussion-oriented instruction. (alpha reliability=.67).

- Teacher leading whole class discussion

- Students engaging in discussion

Exhibit 2.13 in Chapter 2 displays significant differences in pedagogical approaches among schools and types of teachers. Exhibit D.11 provides additional information concerning the ANOVA results.

EXHIBIT D.11

Effects of School Level and Subject on Teachers' Pedagogical Approaches F-Values, Tukey Pairwise Contrasts, and df (n=355)

	Traditional				Nontraditional			
	Didactic		Individual Seatwork		Active		Discussion-oriented[+]	
School Level	42.89***	(df=2, 352)	5.61**	(df=2, 352)	0.55	(df=2, 352)	4.23*	(df=2, 339)
HS-MS	2.86*	(df=1, 210)	1.92	(df=1, 210)	-0.25	(df=1, 210)	-1.86	(df=1, 202)
HS-ES	6.20*	(df=1, 274)	2.24*	(df=1, 274)	-0.73	(df=1, 274)	-3.07*	(df=1, 265)
MS-ES	3.34*	(df=1, 220)	0.32	(df=1, 220)	-0.48	(df=1, 220)	-1.22	(df=1, 211)
Subject	1.09	(df=1, 353)	31.67***	(df=1, 353)	50.69***	(df=1, 353)	0.37	(df=1, 340)
School Poverty Level	16.65***	(df=1, 352)	0.00	(df=1, 352)	0.01	(df=1, 352)	1.06	(df=1, 339)

[+]   n=342

*   Significant at p<.05
**   Significant at p<.01
***   Significant at p<.001

Supplementary Tables

Two of the pedagogy questions ask teachers to report the percentage of time they spend in a selected class on various activities. The results are reported in Exhibit D.12.

EXHIBIT D.12

Time Spent on Class Activities (n=339)

Percent of Time Teacher Spends on Instructional Activities

	Mean	Standard Deviation
Lecturing	19.50	14.49
Providing demonstrations	14.75	9.40
Leading whole-class discussion	15.02	10.95
Working with students in small groups	15.90	10.60
Working with students individually	12.11	9.34
Performing routine administrative tasks	4.67	4.71
Helping students with hands-on experiences[+]	17.29	13.84
Other[+]	0.71	2.98

[+] n=340

Percent of Time Students Spend on Learning Activities

	Mean	Standard Deviation
Listening/taking notes/observing[+]	25.91	16.25
Engaged in discussion	16.07	9.68
Doing lab or field work	16.30	14.84
Completing exercises/taking a test or quiz	15.17	11.62
Reading	6.90	6.54
Completing a performance task, writing[+]	12.22	9.19
Presenting material[+]	6.56	6.55
Other	0.71	3.49

[+] n=338